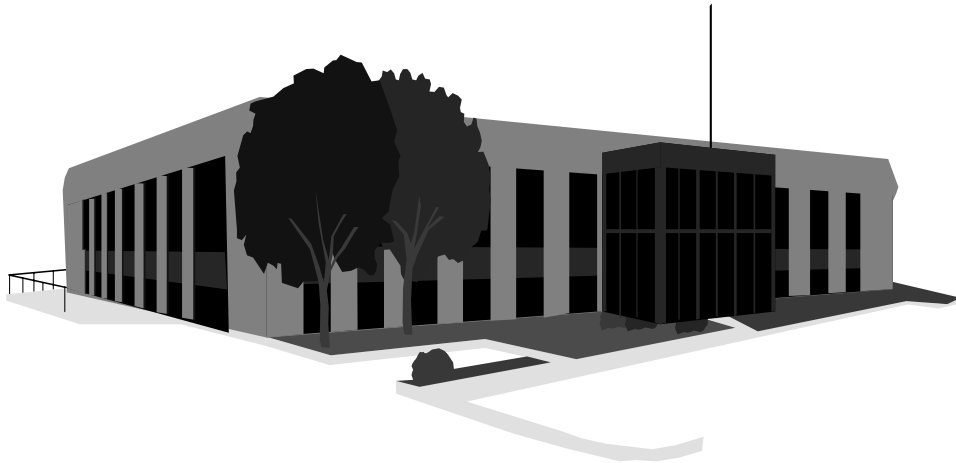


INDOOR AIR QUALITY ASSESSMENT

**Greenfield High School
1 Lenox Avenue
Greenfield, Massachusetts**



Prepared by:
Massachusetts Department of Public Health
Bureau of Environmental Health Assessment
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Background/Introduction

At the request of Lisa Hebert of the Greenfield Board of Health, an indoor air quality assessment was conducted at the Greenfield High School, at One Lenox Ave., Greenfield, Massachusetts. This assessment was conducted by the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health Assessment (BEHA). Reports from building occupants of indoor air quality related symptoms (e.g., headaches, fatigue, etc.) prompted this request. Staff concerns in this building center around water damage and subsequent effects from a chronic roof problem.

On April 14th and 26th, 2000, visits were made to this school by Michael Feeney, Chief of Emergency Response/Indoor Air Quality (ER/IAQ), BEHA, to conduct indoor air quality assessments. Mr. Feeney was accompanied by Burt White, Greenfield School Department Facilities Manager and Ms. Hebert on both days.

The school consists of three distinct sections: the main building, the two-story wing and the vocational education wing. The main wing is a single story red brick building constructed in 1957 (see Picture 1) that contains general classrooms, administrative office, gymnasium, library, cafeteria and auditorium. The two-story wing is a cement, brick and metal frame structure that is attached to the main building on its south wall (see Picture 2). The two-story building contains general classrooms and science laboratories. Classrooms 100 and 200 were added to the western wall of the two-story wing, reportedly in 1982. The date of construction of the two-story wing could not be ascertained, but appears to have been built in the mid-1960's. The vocational education wing is a single story red brick structure reportedly built in the late 1950'-early 1960's. The vocational education wing contains a wood shop, automotive/small engine repair, and art room. Windows are openable throughout the building.

The building houses both high school students as well as students who would be attending the Greenfield Middle School, which was under construction at the time of this assessment. Prior to the Greenfield Middle School renovation, the building reportedly housed a high school student population of approximately 620 students (MDOE, 1997).

Methods

Air tests for carbon dioxide were taken with the Telaire, Carbon Dioxide Monitor and tests for temperature and relative humidity were taken with a Mannix, TH Pen PTH 8708 Thermo-Hygrometer.

Results

The high school currently houses grades 7-12, consisting of a student population of 1,050 and a staff of approximately 170. The tests were taken under normal operating conditions. Test results appear in Tables 1-9.

Discussion

Ventilation

It can be seen from the tables that the carbon dioxide levels were elevated above 800 parts per million parts of air (ppm) in fifty-seven of seventy-three areas surveyed, indicating an overall ventilation problem in the school. Of note were a number of areas which were above 800 ppm with low occupancy and/or open windows (see Tables).

Fresh air in most classrooms is supplied by a unit ventilator (univent) system (see [Figure 1](#)). Univents draw air from outdoors through a fresh air intake located on the exterior walls of the building and return air through an air intake located at the base of

each unit. Fresh and return air are mixed, filtered, heated and provided to classrooms through a fresh air diffuser located in the top of the unit. Univents were off in the majority of classrooms surveyed, indicating that they had been deactivated or were malfunctioning. Obstructions to airflow, such as books, papers and posters over air diffusers, as well as bookcases, tables and desks in front of univent returns, were noted in a number of classrooms. To function as designed, air diffusers and return vents must remain free of obstructions. Importantly, these units must be activated and allowed to operate.

The mechanical exhaust ventilation system consists of wall-mounted exhaust vents. As with the univents, exhaust vents were obstructed by shelves, chairs, boxes and other items (see Picture 3). Without removal by the exhaust ventilation, normally occurring environmental pollutants can build up and lead to indoor air complaints. A number of vents were not operating, which can indicate that exhaust ventilation was turned off, or that rooftop motors were not functioning. BEHA staff examined exhaust motors on the roof and found a number of exhaust motors not operating.

An air-handling unit (AHU) provides ventilation for the 1982 addition. Fresh air is distributed to classrooms in this area by ceiling mounted air diffusers. Exhaust air is drawn back to the AHU through ceiling/wall-mounted grilles connected to ductwork. The configuration of the library ventilation system tends to create conditions for stagnant air to accumulate in part the library. The glass walls of the library appear to have originally been part of the exterior wall prior to the construction of the two-story wing. Private offices line the interior wall of the library (see Figure 2). Fresh air is supplied by ceiling-mounted air diffusers, but no exhaust vents exist in the library. The library private offices do not have fresh air supplies, but do have ceiling mounted exhaust vents. The ventilation system in the library was designed to provide fresh air into the main area

of the library, which would then be drawn through the doorway of each private office to the exhaust vent. Unfortunately, the airflow pattern created by this design is disrupted when the private office doors are closed, since these doors are not undercut nor do they have passive door vents to allow airflow into them (see Picture 4). When doors are closed, the main area of the library has minimal exhaust ventilation and the offices have minimal fresh air supply. Enhancing this effect is the placement of the ceiling-mounted fresh air diffusers in the center of the library ceiling.

With functional exhaust ventilation, fresh air from the air diffusers will tend to be drawn back to the main offices, decreasing distribution to the former exterior wall (see Figure 3). This condition would lead to stagnant air in the former exterior wall side of the library. Further enhancing this effect is the existence of a skylight, which heats the air of the former exterior wall side of the library (see Picture 5). The combination of lack of airflow and heat from the skylight tends to make the outer half of the main library area uncomfortable. The wood shop also has a ceiling-mounted AHU (see Picture 6). It appears the fan motor was removed, rendering this AHU inoperable.

To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air from the room. The date of the last balancing of these systems was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 15 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and

maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The Department of Public Health uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches.

Temperature readings ranged from 68°F to 77°F, which was close to the BEHA's recommended comfort guidelines. The BEHA recommends that indoor air temperatures be maintained in a range of 70°F to 78°F in order to provide for the comfort of building occupants. A number of temperature complaints were expressed, which may indicate problems with the heating system and/or thermostat control. Temperature control can also be difficult in areas without operating mechanical supply and exhaust ventilation. In many cases concerning indoor air quality, fluctuations of temperature in

occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity in the building was below the BEHA recommended comfort range in all areas sampled. Relative humidity measurements ranged from 9 to 24 percent. The BEHA recommends that indoor air relative humidity is comfortable in a range of 40 to 60 percent. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a common problem during the heating season in the northeast part of the United States.

Microbial/Moisture Concerns

Several rooms and hallways had water stained ceiling tiles, which is evidence of historic and/or current roof or plumbing leaks. The roof was examined during a rainstorm on April 26, 2000. As reported by school officials, the roof consists of a foam rubber-like material that is covered with a spray coating. The use of these materials has created a surface with numerous ridges (see Pictures 7 through 9) that create troughs in the roof. This renders roof drainage impossible, since water can collect in the numerous troughs without being directed to a roof drain. The collection of water and the subsequent freezing and thawing during winter months can lead to roof leaks and water penetration into the interior of the building. Pooling water can also become stagnant, which can lead to mold and bacterial growth, give off unpleasant odors and provide a breeding ground for mosquitoes.

Damage to the roof exists in many areas. Since the surface of the roof is a spray on material, it would be expected to consist of a thin layer, which could render the roof more susceptible to mechanical damage. In one area, the roof has holes that were created

by an individual walking in cleated athletic shoes (see Picture 10). Numerous other cracks and holes in the outer coat were noted (see Picture 11). School officials attribute this damage to birds pecking at the roof. Birds can consume coarse gritty materials or stones that lodge in the gizzard to aid in digestion of food (Hickman, C.P, Hickman C.P., Hickman, F.M., 1978). While no birds were observed damaging the roof, deep, puncture holes were noted in many areas (see Picture 12). In one instance, a plant was found growing from a crack in the roof (see Picture 13). Each of these cracks, holes and other forms of penetration through the exterior coat of the roofing material can result in water penetration into the building envelope. As an example, an active water leak was noted in the industrial arts hallway outside classroom 91.

While the roof appears to have numerous breeches in its outer coating, water damage to ceiling tiles appeared to be heaviest around sealed skylights. Ceiling tiles can provide a source of mold and mildew, especially if wetted repeatedly. These materials should be repaired/replaced after a water leak is discovered and repaired.

Water damaged carpeting was observed in the area of room 200 on the second floor of the two-story wing. These rooms were built on a cement slab that extends approximately thirty-six inches horizontally from the exterior of the building. This design allows rainwater and/or snow to collect on the horizontal surface and pool/drift against the exterior walls and univent fresh air intakes (see Picture 14). This results in water penetration into the interior of classrooms through fissures and cracks in exterior walls. This water penetration presents itself in the characteristic form of water damaged carpeting along window frame edges. The American Conference of Governmental Industrial Hygienists (ACGIH) recommends that carpeting be dried with fans and heating within 24 hours of becoming wet (ACGIH, 1989). If carpets are not dried within this

time frame, mold growth may occur. Water-damaged carpeting cannot be adequately cleaned to remove mold growth.

Several classrooms contained plants in outdoor window planters, and/or hanging plants suspended above carpeting without drip pans. Outdoor window planters are designed to be mounted on the outside of windows and therefore do not usually have drip pans. The lack of drip pans can lead to water pooling and mold growth on windowsills and carpeting when used indoors. Moistened plant soil, drip pans and standing water can serve as a source of mold growth. Plants should be equipped with drip pans and over watering should be avoided. Plants were noted on top of univent fresh air diffusers. Plants should be located away from univents and exhaust ventilation to prevent the aerosolization of dirt, pollen or mold.

Other Concerns

A number of other conditions that can potentially affect indoor air quality were noted during the assessment. The chemistry lab (room 108) has a carpeted floor. Located in the chemistry lab is a chemical hood (see Picture 15). Carpeting in laboratories is ***not recommended*** as a floor covering for several health and safety reasons. First, laboratory floors frequently become wet from spilled water, which if not dried, can serve as a mold growth medium. Of important note is the possibility of the carpet becoming contaminated by chemical spills. A carpet contaminated with chemicals may also serve as a reservoir for off-gassing of irritating substances. Once contaminated with chemicals, cleaning of the carpet is not a viable option. All contaminated surfaces of the carpet would be considered as a hazardous waste, requiring disposal in a manner consistent with Massachusetts hazardous waste laws and regulations. Of further concern is the interaction of spilled chemicals with the constituent materials of the carpet itself.

Frequently carpet consists of man-made materials (i.e., synthetic fibers). If contaminated with an organic solvent or strong acid, synthetic fiber may breakdown into its constituent chemicals, resulting in the release of hazardous materials. Some chemicals may react violently with synthetic materials resulting in fire. For these reasons a smooth, nonporous, nonflammable floor covering is preferred in science laboratories.

Also of note were the conditions that indicate improper storage of chemicals that may pose fire and safety hazards. Of concern is the condition of the flameproof cabinet in the chemical storeroom adjacent to room 108. This cabinet is connected to ductwork, which is installed to a rooftop exhaust vent. The National Fire Prevention Association (NFPA) does not require venting in flammable storage cabinets, however, if venting is done, it must be vented directly outdoors and in a manner not to compromise the specific performance of the cabinet (NFPA, 1996). If air backflow from outdoors into the cabinet through the venting occurs, off-gassing chemicals can be forced from the flammable storage cabinet into the storeroom. Proper design of exhaust vents should prevent air backflow into the cabinet. The installation of the exhaust vent ductwork has compromised the fire integrity of the cabinet. With this system deactivated, the ductwork itself can serve as a source of oxygen, which in the presence of a heat source can ignite a sufficient concentration of off-gassing flammable VOC vapor. In its present state, the flameproof cabinet may pose a fire hazard.

The acid cabinet (which appears to be a flameproof cabinet painted blue) is connected to a duct by a bunghole at the base of the cabinet (see Picture 16). The flameproof cabinet is connected to the same duct by its bunghole. The acid cabinet as well as the flameproof cabinet are connected by this *common* single duct that is connected to an exhaust vent motor. Also in this duct is a vent that appears to draw air from the chemical storeroom. Since the cabinets are connected to a common duct, it is

possible that off-gassing VOCs from the flameproof cabinet and evaporating acids from the acid cabinet can mix and react within the ductwork. Acids and VOCs should not be mixed in order to prevent unintended chemical reactions. It is also possible that when the exhaust vent motor is deactivated, off-gassing chemicals may penetrate into the chemical storeroom by the ductwork vent. Other problems noted in the science area which are or can be a fire and/or safety hazard include:

1. Shelves in the acid cabinet are heavily corroded from off gassing acids (see Pictures 17). Corrosive materials appear to have corroded the metal shelf supports, coating the shelf with oxidized metal. The corroding of the metal shelf supports can lead to the undermining of the structural integrity of the shelves. An accidental bump to the shelf could cause these shelves to fail, resulting in the breakage of the glass containers and subsequent opportunity for acid release into the chemical storage area. Under the observed condition of these shelves, it is highly recommended that stored containers be removed to prevent shelf failure. Acids should be stored in an acid resistant cabinet.
2. Bottles in the acid storage cabinets are coated with crystals, (see Pictures 18) indicating chronic off gassing of the container contents.
3. One bottle was stopped with a cork made of a rubber material, which has begun to deteriorate (see Picture 17), indicating an incompatible material with rubber is stored in this container.
4. Flammable materials were stored on top of or outside of the flameproof cabinet
5. A container of Cuprinol[®] wood preservative appears to have a leak (see Picture 19).
6. Chemical stock bottles are reused to store other materials.

7. Shelves do not have guardrails to prevent accidental breaks of chemical containers.
8. There are a number of unlabeled containers filled with unknown materials. Other containers had labels that were either damaged or missing.

It is highly recommended that a thorough inventory of chemicals in the science department be done to assess chemical storage and disposal in an appropriate manner consistent with Massachusetts hazardous waste laws.

The art room (room 87) has two unvented pottery kilns (see Picture 20). Pottery kilns can produce carbon monoxide and sulfur dioxide, which can cause respiratory symptoms in exposed individuals (McCann, M., 1985). Local dedicated exhaust ventilation is necessary to remove kiln-generated pollutants from the indoor environment. The art room also has a number of flammable materials stored on an open shelf (see Picture 21). Flammable materials should be stored in a flameproof cabinet that meets the specifications of the NFPA (NFPA, 1996).

Several classrooms contained excessive chalk dust; the art room had heavy accumulations of clay dust. Many classrooms are equipped with pencil sharpeners mounted on windowsills. Several of these pencil sharpeners had no containment for pencil shavings. Pencil shavings, chalk dust and clay dust can become easily aerosolized and serve as eye and respiratory irritants.

A number of classrooms contained dry erase boards and dry erase board markers. Materials such as dry erase markers and dry erase board cleaners may contain volatile organic compounds (VOCs), such as methyl isobutyl ketone, n-butyl acetate and butyl-cellusolve (Sanford, 1999). Dry erase board markers and cleaners can be irritating to the eyes, nose and throat.

The art room and automotive/small engine shop have grinding wheels (see Pictures 22 through 24) that do not have dedicated local exhaust ventilation to remove metal fumes produced during grinding operations. Metal fumes are a respiratory irritant. Both the Occupational Safety and Health Administration (OSHA) and the American Conference of Governmental Industrial Hygienists (ACGIH) have established Permissible Exposure Limits (PELs) (OSHA, 1997) and Threshold Limit Values (TLVs) (ACGIH, 1999) for various metal fumes. An evaluation of the contents of the materials producing fume must be done in order to ascertain which PEL or TLV applies in this situation. This evaluation, as well as an evaluation of the concentration of materials being aerosolized, should be done by a certified industrial hygienist. Please note that these exposure standards apply to healthy adult employees in the workforce. Students who are in this environment are not considered employees for the purposes of OSHA regulations or ACGIH TLVs. In this case, levels of airborne fumes should be reduced to minimally feasible levels in order to prevent student exposure to metal fumes. The ACGIH has recommended standards for local exhaust ventilation for specific operations such as surface grinders, grinding wheels, lathes, and metal band saws (ACGIH, 1998). If this is not practicable, individual personal protective equipment that is fit-tested for each individual should be considered.

The faculty workroom contained two large photocopiers. Volatile organic compounds (VOCs) and ozone can be produced by photocopiers, particularly if the equipment is older and in frequent use. Ozone is a respiratory irritant (Schmidt Etkin, D., 1992). No additional local exhaust ventilation is provided for this room. Without adequate exhaust ventilation, pollutants produced by office equipment can build up. Additional local exhaust ventilation would help reduce odors, pollutants, and excess heat in this area.

An ozone generating air purifier was noted in one classroom. At this time, the efficacy of ozone as an indoor air cleaner is being examined by several government agencies. While ozone may be effective in removing some odors of biological origin (such as skunk), its use as a universal air cleaner has come under question. (EPA, 1998). Ozone is a highly irritating substance to the respiratory system. Until more definitive information becomes available, the use of ozone generators in occupied areas should be done with caution.

Several areas contained window-mounted air conditioners and/or portable air purifiers. This equipment is normally equipped with filters, which should be cleaned or changed as per the manufacturer's instructions to avoid the build up and re-aerosolization of dirt, dust and particulate matter.

A noticeable odor of wood dust was detected in the hallway outside of the wood shop. Spaces exist between and under the wood shop doors (see Picture 25), which can allow dusts/odors to migrate into adjacent areas of the school. A number of wood cutting/sanding machines are connected to the wood-dust collecting system via ductwork, other equipment is not. It was reported to BEHA staff that several of the ducts to the wood dust collection system were disconnected due to excessive clogging by wood dust (see Picture 26). In addition, a ceiling mounted heating unit contains a filter, which was also clogged with accumulated materials (see Picture 27). Filters should be changed as per the manufacturer's instructions, or more frequently if needed, to avoid the build up and re-aerosolization of wood dust and particulate matter.

Classroom 225 contained a number of empty soda cans stored for recycling purposes. These items should be rinsed out with water and sealed in plastic bags. Improperly stored food and beverage containers can serve as a source of mold and mildew growth as well as a food source for pests.

The automotive/small engine shop contains floor drains that appear to have dry traps, which can allow for sewer gas to back up into the shop. Sewer gas can be irritating to the eyes, nose and throat. This shop also has a floor installed vehicle exhaust vent system (see Picture 28) to direct automotive exhaust out of the building. The exhaust pipe of the vehicle is connected to the exhaust vent system by a flexible hose. As the motor runs, the system is pressurized and exhaust exits the building. Of note is the existence of an access vent for the vehicle exhaust system in classroom 97 (see Picture 29). If this vehicle exhaust system is used and the vent cover in classroom 97 is not airtight, vehicle exhaust may penetrate into this classroom. Vehicle exhaust should be vented outdoors to prevent build-up of carbon monoxide in interior space.

Oil odors were also noted by BEHA staff in the automotive/small engine shop. Open containers of motor oil and absorbent material (see Pictures 30 and 31) on the floor were noted in this shop. The presence of absorbent material is usually indicative of past oil spills. Oil absorbent materials should be removed once applied. Such materials can be a continuing source of odors and should be removed after use. Oil vapor can be irritating to the eyes, nose and throat.

Univents are equipped with filters that strain particulates from airflow. These filters provide minimal filtration of respirable dusts. In order to decrease aerosolized particulates, disposable filters with an increased dust spot efficiency can be installed in the univents. The dust spot efficiency is the ability of a filter to remove particulates of a certain diameter from air passing through the filter. Filters that have been determined by ASHRAE to meet its standard for a dust spot efficiency of a minimum of 40 percent (Minimum Efficiency Reporting Value equal to 9) would be sufficient to reduce many airborne particulates (Thornburg, D., 2000; MEHRC, 1997; ASHRAE, 1992). Note that increasing filtration can reduce airflow (called pressure drop) which can reduce the

efficiency of the univent due to increased resistance. Prior to any increase of filtration, each univent should be evaluated by a ventilation engineer to ascertain whether it can maintain function with more efficient filters.

The building shows signs of termite infestation. Termite damaged wood was noted in the east side of the main building (see Pictures 32 and 33). In an effort to treat the termites, maintenance staff applied a pyrethroid pesticide to the floor of the room. This pesticide was removed upon return on April 26, 2000 by BEHA staff. Termite infestation results from penetration through holes in the exterior of a building (see Picture 34) at areas where wood is chronically damp. A three-step approach is necessary to eliminate pest infestation:

1. removal of the termites;
2. reduction/elimination of pathways/food sources that are attracting termites;
and
3. repair of the damage wrought by the termites.

To discontinue damage to the building, termites must be removed from the building.

Under current Massachusetts law that will go into effect November 1, 2001, the principles of integrated pest management (IPM) must be used to remove pests in schools (Mass Act, 2000).

Conclusions/Recommendations

The conditions found at the Greenfield High School present a number of problems that require a series of remedial steps. For this reason a two-phase approach is required, consisting of immediate (**short-term**) measures to improve air quality within the school and **long-term** measures that will require planning and resources to adequately address overall indoor air quality concerns.

In view of the findings at the time of this assessment, the following **short-term** recommendations are made:

1. Disconnect the flameproof storage cabinet from the duct and reseal the bung hole with the original bungs. If the original bungs cannot be located, contact the cabinet manufacturer to obtain replacements. Consider obtaining an acid resistant cabinet for the chemical storeroom.
2. Consider removing carpeting from science lab.
3. Examine the carpet in the 1982 addition for mold growth. If moldy, it is recommended to discard the carpet and disinfect the floor with an appropriate antimicrobial.
4. Undercut doors of private offices by one inch to allow air from the main library to be drawn into library private offices when office doors are closed.
5. Render the vehicle exhaust vent in room 97 airtight.
6. Survey classrooms for univent function to ascertain if an adequate air supply exists for each room and make univent repairs as needed. Check fresh air intakes for repair and increase the percentage of fresh air intake if necessary.
7. Inspect exhaust motors and belts periodically for proper function; repair and replace as necessary.
8. Remove blockages of univent air diffusers, univent return vents and exhaust vents.
9. To maximize air exchange, the BEHA recommends that both supply and exhaust ventilation operate continuously during periods of school occupancy independent of classroom thermostat control. Consider having the systems balanced by a professional Heating, Ventilation and Air Conditioning (HVAC) engineer.

10. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a High Efficiency Particulate Arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
11. Repair any water leaks and replace any remaining water-stained ceiling tiles. Examine the areas above these tiles for mold growth. Disinfect areas of water leaks with an appropriate antimicrobial as needed.
12. Move plants away from univents and ensure drip pans are placed underneath plants in classrooms. Examine plants in classrooms for mold growth in water catch basins. Disinfect water catch basins with an appropriate antimicrobial if necessary. Ensure drip pans are placed underneath plants in classrooms. Consider discontinuing the use of window planters and hanging plants above carpeting in classrooms.
13. Examine the junction between the wall and cement slab of the two-story section for water tightness. Waterproof seams to prevent further water intrusion.
14. Examine the feasibility of installing a local exhaust ventilation system for the art room kilns. Consider limiting the use of these kilns until an appropriate local exhaust ventilation system is installed.
15. Have a chemical inventory done in all storage areas and classrooms. Consider having an experienced hazardous waste removal consultant evaluate the chemical storerooms for proper chemical storage and recommendations for removal of

- hazardous waste. Discard hazardous materials or empty containers of hazardous materials in a manner consistent with environmental statutes and regulations.
- Follow proper procedures for storing and securing hazardous materials.
16. Consider obtaining an acid resistant storage cabinet or reduce or eliminate acid use in chemistry area.
 17. Store flammable materials in flameproof cabinets in a manner consistent with state and local fire codes.
 18. Obtain Material Safety Data Sheets (MSDS') for chemicals from manufacturers or suppliers and maintain MSDS'. Train individuals in the science department in the proper use, storage and protective measures for each material in a manner consistent with the Massachusetts Right-To-Know Law, M.G.L. c. 111F (M.G.L., 1983).
 19. Clean chalkboards and chalk trays regularly to prevent the build-up of excessive chalk dust.
 20. Ensure that water is poured into floor drains in the vocational education wing at least twice a week to maintain the water seal in drain traps.
 21. Remove oil contaminated absorbent materials on the floor of the automotive/small engine shop. Store used oil in a sealed container.
 22. Repair/replace pencil sharpeners to avoid the aerosolization of wood/pencil shavings.
 23. Properly rinse empty recycling containers and seal in plastic bags to avoid mold growth, unpleasant odors and attraction of pests.
 24. Change filters in window-mounted air conditioners as per the manufacturer's instructions to prevent the re-aerosolization of dirt, dust and particulate matter.

25. Change filters for univents as per the manufacturer's instructions, or more frequently if needed. Clean and vacuum interior of univents prior to operation to avoid the re-aerosolization of accumulated dirt, dust and debris. Examine the feasibility of installing a higher-grade filter in univents. Consider consulting a ventilation engineer prior to any increase in filter efficiency to evaluate univents.
26. Consider removing the ozone generator from the building. If used, adequate ventilation should be used to prevent the build up of ozone levels within offices.
27. Install weather-stripping on woodshop door to prevent woodshop odors/dusts from penetrating into adjacent areas of the school. Do not conduct wood shop activities with the hallway door open during hours of school occupancy.
28. Restore wood dust collection system to proper function. Clean/replace filter for wood dust collector as recommended by the manufacturer or more frequently if needed.
29. Use IPM to remove termites from the building. A copy of the IPM recommendations is included with this report as Appendix A (MDFA, unknown). Activities that can be used to eliminate pest infestation may include the following activities.
 - i) Consult a licensed pesticide applicator on the most appropriate method to end the termite infestation.
 - ii) Once termite colony is eliminated, identify the source of moisture wetting wood and repair.
 - iii) Remove termite infested wood.
 - iv) Reseal the building envelope to eliminate termite pathways into building.
 - v) Reduce harborages (cardboard boxes) where termites may reside.

The following **long-term** measures should be considered:

1. Consider consulting a building engineer about possible options to eliminate water pooling on roof. Options to reduce water pooling may include: resealing over the existing roof or total roof replacement.
2. Several classrooms do not have mechanical ventilation (see Tables). Examine the feasibility of installing mechanical ventilation in these areas.
3. Examine the feasibility of installing local exhaust ventilation to draw air towards the former exterior wall of the library. It may be possible to use an unused fireplace (see Picture 35) as a ready made exhaust vent. Exhaust ventilation may be achieved by installing an exhaust vent motor on the chimney (see Picture 36) and installing either a passive vent or ductwork on the library's former exterior wall.
4. Consider installing local exhaust ventilation for photocopiers to help reduce odors, pollutants and excess heat. If not feasible, relocate the equipment to an area with adequate ventilation.
5. Consider installing local exhaust ventilation for grinding wheels located in the art room and automotive/small engine shop.

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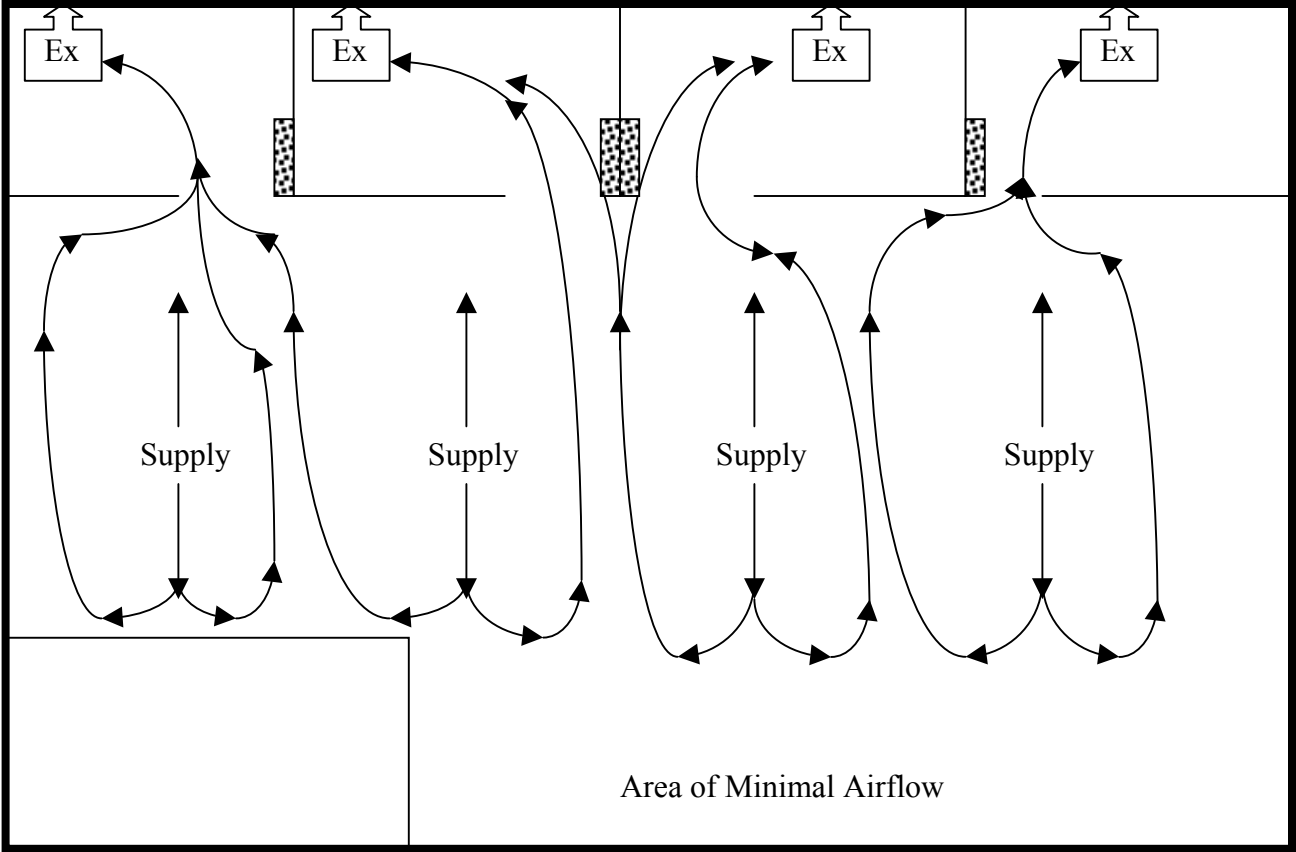
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Figure 2

Example of Airflow with Library Private Office Doors Open



Key

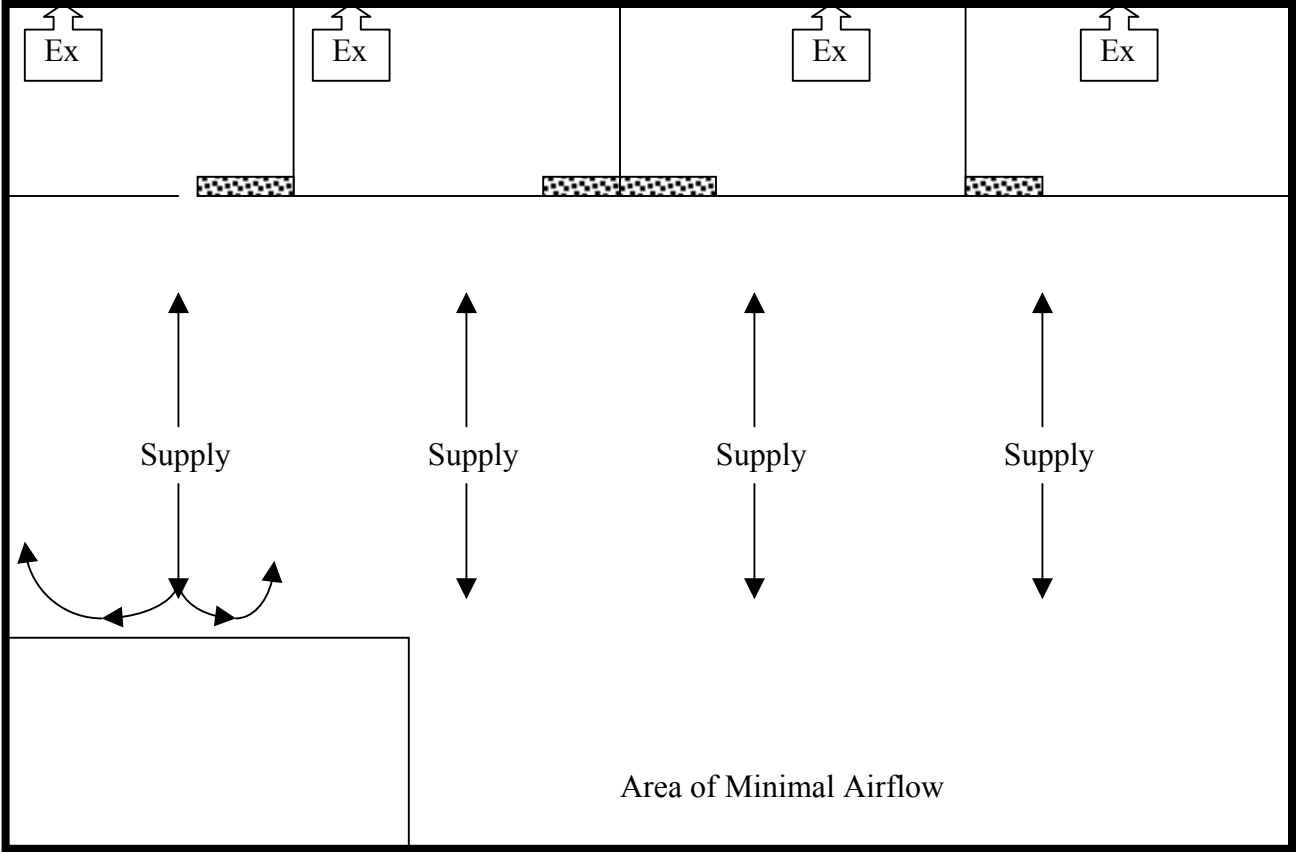
→ Direction of Airflow

 Office Door

Picture Not to Scale


Figure 3

Example of Airflow with Library Private Office Doors Closed



Key

→ Direction of Airflow

 Office Door

Picture Not to Scale

Picture 1



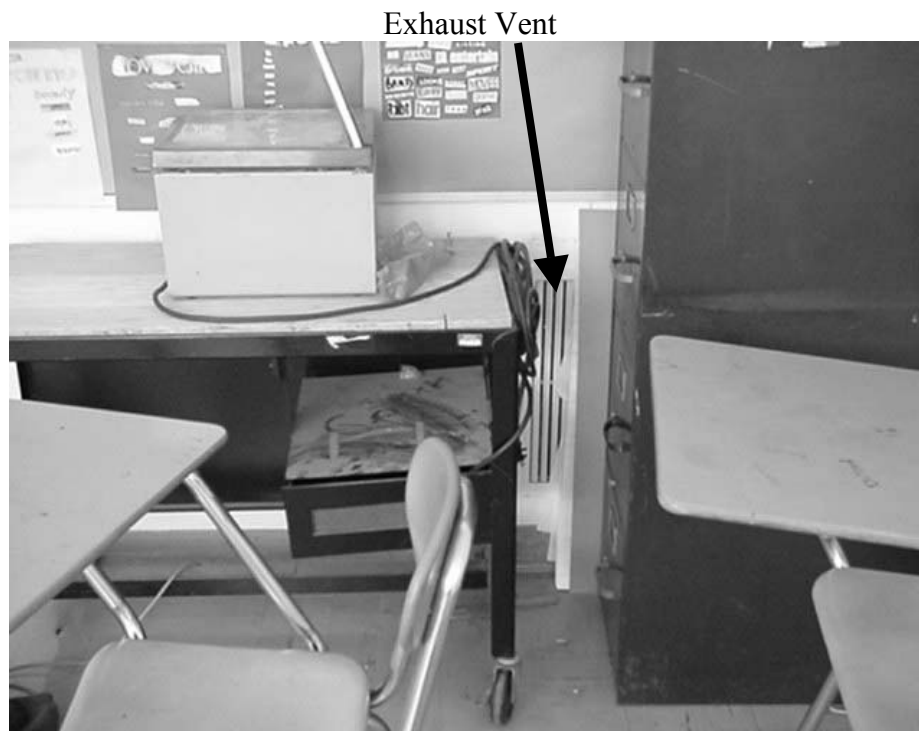
Main Section Of Greenfield High School With Gymnasium And Auditorium Structures In Background

Picture 2



**Two Story Section Attached To the South Wall of The Main Section
With 1982 Addition on Its West Wall**

Picture 3



Example of Blocked Exhaust Vent

Picture 4



Library Private Office Door, Note That the Door Is Flush With the Floor

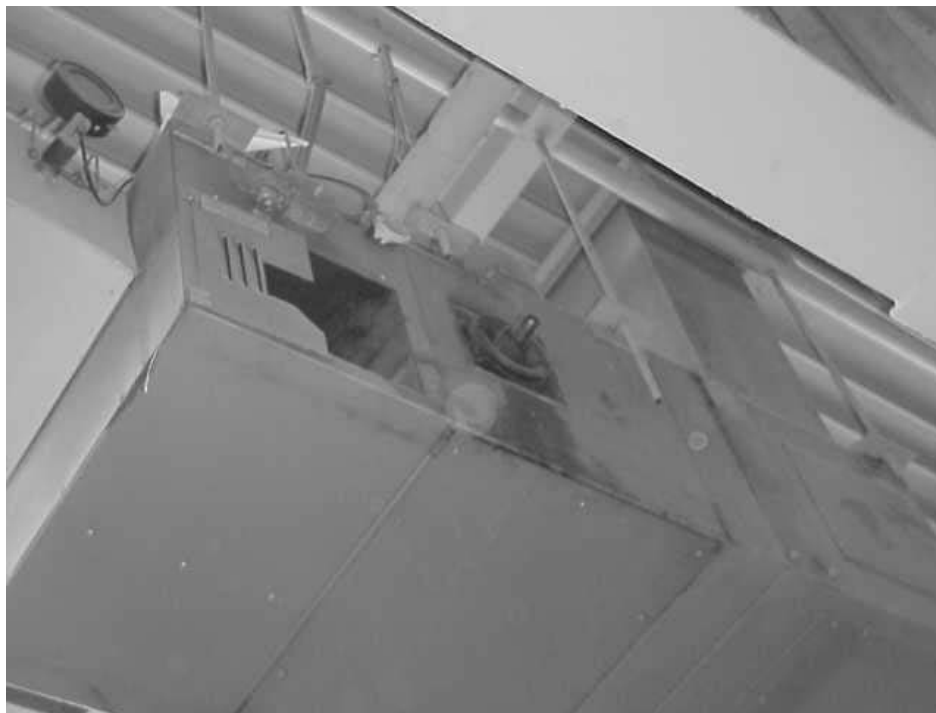
Picture 5

Former Exterior Wall



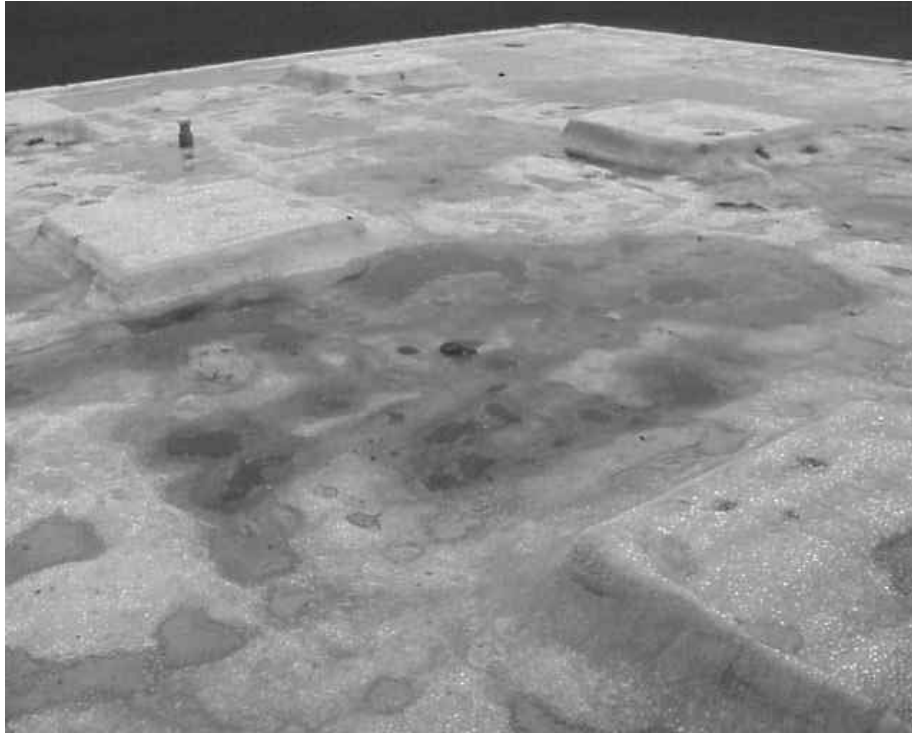
Skylight in Library with Former Exterior Glass Wall

Picture 6



Missing Motor from Wood Shop AHU

Picture 7



Greenfield High School Roof, Note Sealed Former Classroom Skylights (Box-Like Structures)

Picture 8



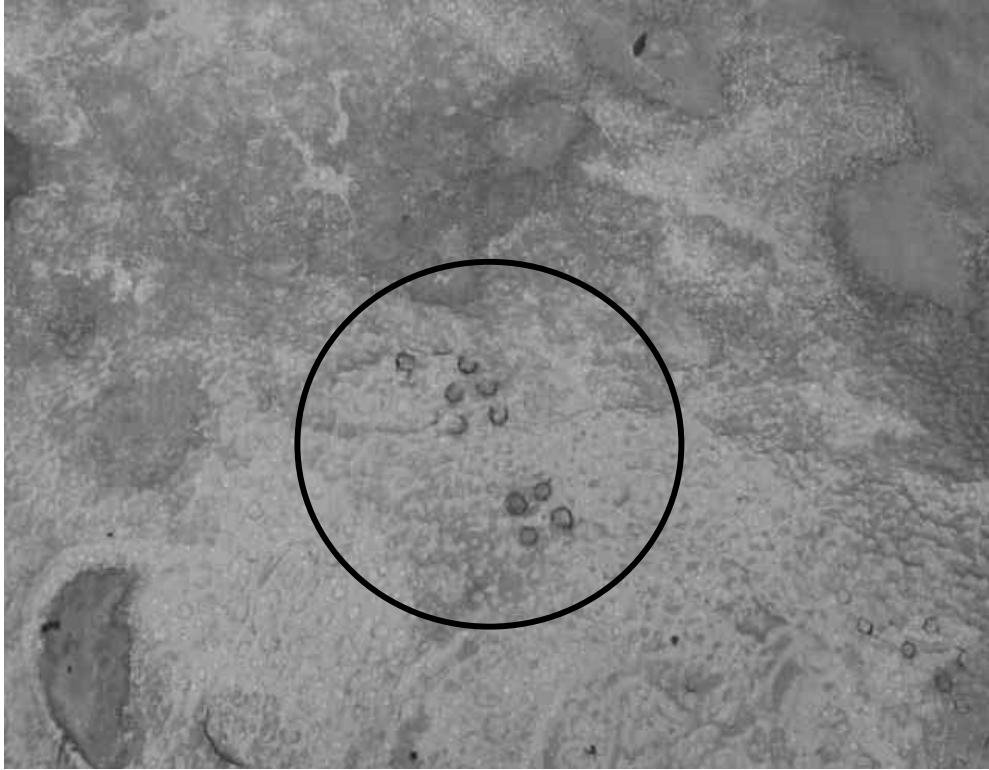
**Roof Drain Opening, Note Pooling Water in Troughs
That Do Not Direct Water to Drain**

Picture 9



Repaired Section of Roof, Note Pooling Water Created by Troughs in Repaired Roof

Picture 10



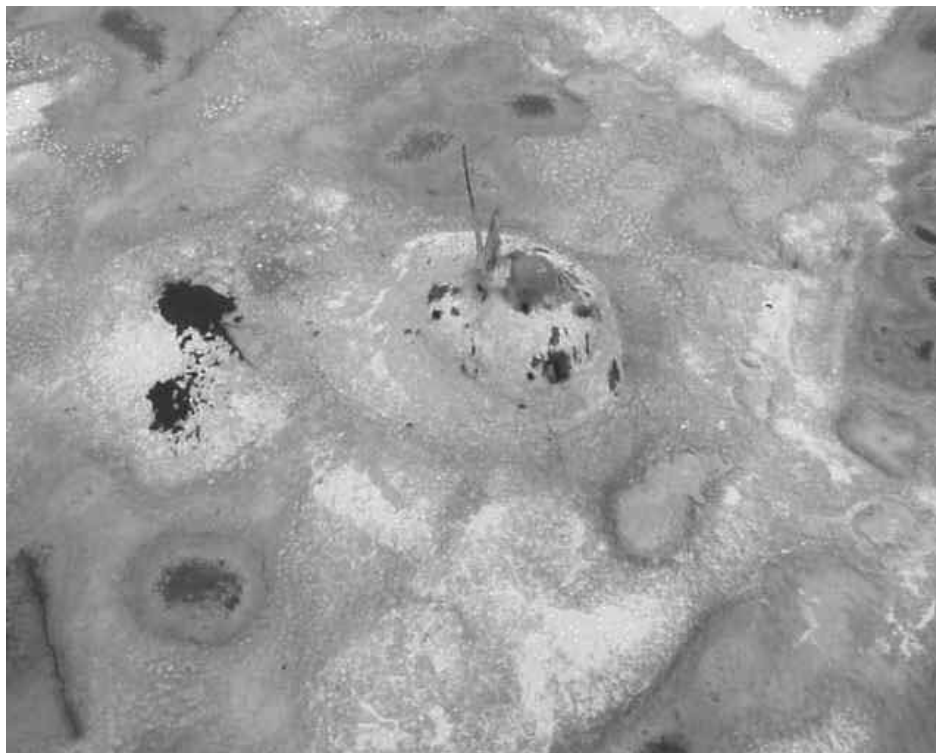
Damage To Roof Surface from Cleat Mark

Picture 11



Typical Cracking Of Top Surface of Roof

Picture 12



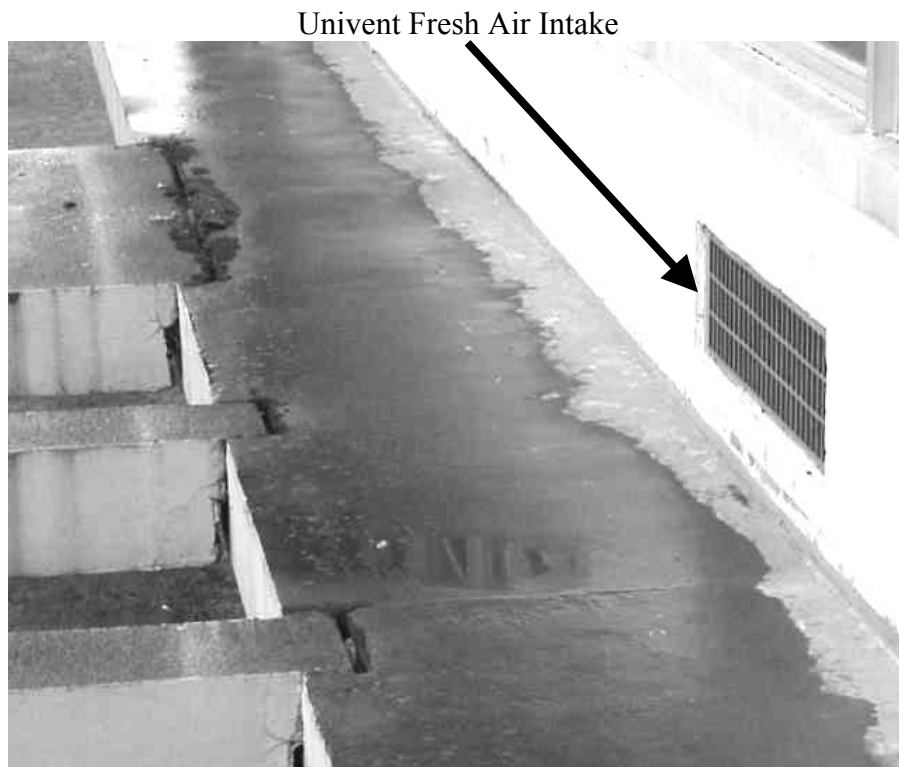
Puncture Damage on Roof Attributed to Birds

Picture 13



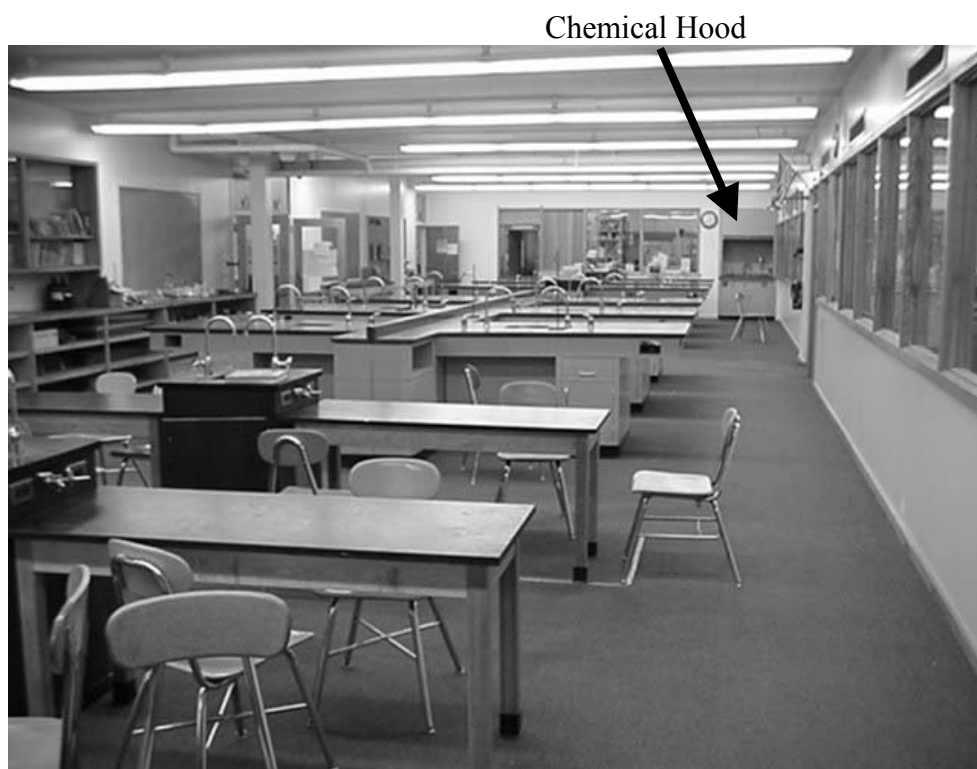
Plant Growing in Roof Crack

Picture 14



Cement Slab of Two-Story Section

Picture 15



Carpeted Chemistry Lab, Note Chemical Hood on Rear Wall

Picture 16

Exhaust Vent Duct



Exhaust Duct Shared by Flameproof Cabinet and Acid Storage Cabinet

Picture 17

Rubber Stopper



**Corrosion on Metal Shelf Supports in Acid Storage Cabinet,
Note Collapsed Rubber Stopper in Bottle**

Picture 18



Bottles With Crystals on Caps in Acid Storage Cabinet

Picture 19



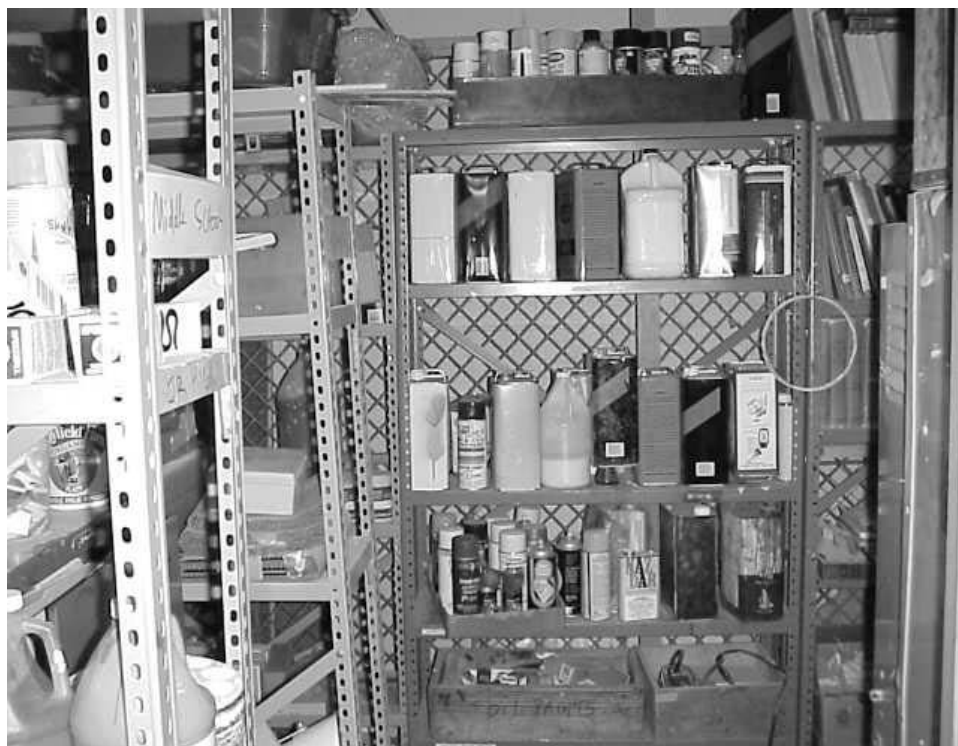
Possibly Leaking Container of Cuprinol®

Picture 20



Unvented Pottery Kilns in Art Room

Picture 21



Flammable Materials Stored In Art Room

Picture 22



Unvented Grinding Wheel in Art Room

Picture 23



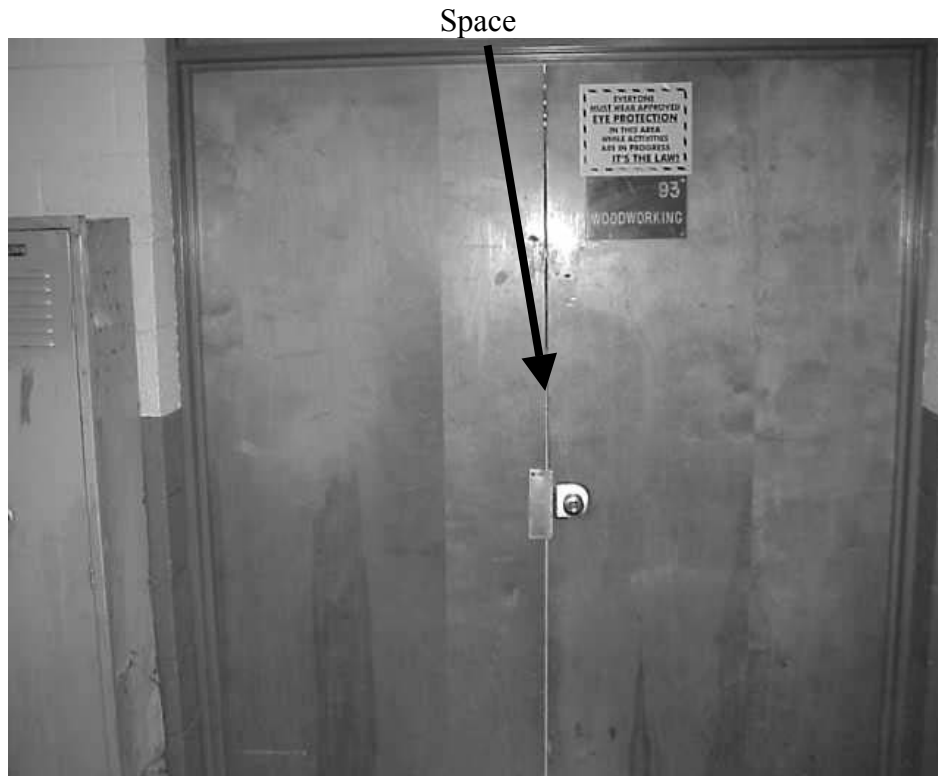
Unvented Grinding Wheel in Art Room

Picture 24



Unvented Grinding Wheel and Saw In Automotive/Small Engine Shop

Picture 25



Space in Wood Shop Hallway Door

Picture 26



Below Floor Dust Collection Vents Clogged with Sawdust

Picture 27

Saw Dust Clogged Filter



Saw Dust Clogged Ceiling Mounted Heater

Picture 28



Vehicle Exhaust Vent In Automotive/Small Engine Shop

Picture 29



Vehicle Exhaust Vent In Room 97

Picture 30



Open Containers of Motor Oil

Picture 31



Absorbent Material on the Floor of the Automotive/Small Engine Shop

Picture 32



Termite Damaged Wood Inside Wall Cavity beneath Windows

Picture 33



Termite Damage Beneath Classroom Sink

Picture 34



Seam In Window Frame near Classroom with Termite Damage

Picture 35



Unused Fireplace Hearth in Hallway opposite Library

Picture 36



Chimney on Roof of Two-Story Wing That Is Connected To Hearth in Hallway Outside Of the Library

TABLE 1

Indoor Air Test Results –Greenfield High School, Greenfield, MA – April 14, 2000

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	441	61	9					
2 nd Floor Break Room	1335	73	14	0	yes	yes	yes	wall mounted supply/exhaust vents
203	1600	74	18	12	yes	yes	yes	exhaust off, water damaged wall, pencil shavings, door open
200A	1278	73	16	0	no	yes	yes	
204	1085	73	14	16	yes	yes	yes	door open
200B	1195	74	16	2	yes	yes	yes	plants, pencil shavings, door open
205	1103	74	13	1	yes	yes	yes	cleaning product, carpet
206	1009	73	15	0	yes	yes	yes	chalk dust, supply off
207	1488	73	11	20	yes	yes	yes	supply off-blocked by books, dry erase board
208	1438	73	18	17	yes	yes	yes	supply off-switch
209	1623	75	19	36	yes	yes	yes	supply off, exhaust blocked by file cabinet

* ppm = parts per million parts of air
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 2

Indoor Air Test Results –Greenfield High School, Greenfield, MA – April 14, 2000

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
210	1104	73	12	0	yes	yes	yes	supply off, exhaust blocked by file cabinet
28	949	74	15	17	yes	yes	yes	supply off
27	873	75	13	4	no	yes (3)	yes (2)	2 out of 3 supply vents on, both exhaust vents on
80	771	74	11	17	yes	yes	yes	window open, window mounted air conditioner (a/c), 3 CT
82	718	71	11	15	yes	yes	yes	window open, 4 CT
83	1118	73	16	19	no	yes	yes	
65	819	72	15	4	yes	yes	no	supply off, termites
66	829	72	14	2	yes	yes	yes	supply off, termites
62	809	72	16	2	yes	yes	yes	supply and exhaust off, plant blocking supply, chalk dust
60/61	864	73	17	1	yes	yes	yes	exhaust off, 6 CT, plant
Gym	706	70	14	0	no	yes	yes	supply and exhaust off

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Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 3

Indoor Air Test Results –Greenfield High School, Greenfield, MA – April 14, 2000

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Library Office	1063	75	15	0	no	no	yes	musty odor, door open
227	1075	71	13	0	yes	yes	yes	window open, supply off, exhaust blocked by sofa, dry erase board
226	1235	72	16	4	yes	yes	yes	window open supply off
225	1043	75	13	8	yes	yes	yes	window and door open, supply off, exhaust blocked by shelf, chalk dust, soda cans
223	1043	74	13	0	yes	yes	yes	supply and exhaust off
222	910	75	11	0	yes	yes	yes	supply off
2 nd Floor Men's Restroom						no	yes	
2 nd Floor Women's Restroom						no	yes	
221	802	75	11	0	yes	yes	yes	exhaust off, 28 computers, window mounted a/c, skunk odor
218		73	9	0	yes	yes	yes	exhaust off, window open, chalk dust

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Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 4

Indoor Air Test Results –Greenfield High School, Greenfield, MA – April 14, 2000

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
101	1146	76	15	38	yes	yes	yes	supply and exhaust off, window and door open, shrub
100	902	72	12	2	yes	yes	yes	ceiling plenum exhaust, 1 ceiling tile ajar, door open
211	779	72	11	0	yes	yes	yes	
212	1200	74	14	0	yes	yes	yes	supply off, window open
213	928	74	12	2	yes	yes	yes	exhaust blocked by file cabinet, window open
214	970	72	12	0	yes	yes	yes	supply off, exhaust blocked by box
215	1217	70	16	0	yes	yes	yes	supply off, exhaust blocked by shelf
216	675	68	13	0	yes	yes	yes	supply off, exhaust blocked by shelf, window open
114	883	69	16	28	yes	yes	yes	exhaust blocked by board, door open
112	615	69	15	0	yes	yes	yes	supply off, window open, sink seam
Library	966	75	13	6	yes	yes (6)	no	all supply vents on

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Comfort Guidelines

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> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 5

Indoor Air Test Results –Greenfield High School, Greenfield, MA – April 14, 2000

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
ESL	1021	75	14	1	no	no	yes	
119	1681	72	21	15	yes	yes	yes	supply off, exhaust blocked by file cabinet
118	1518	72	18	11	yes	yes	yes	exhaust off
ISS	1053	73	15	10	yes	no	no	
35	1238	75	16	18	yes	yes	yes	supply off, window open, dry erase board
32	1137	75	14	17	yes	yes	yes	supply off, exhaust blocked by map, window and door open, dry erase board, chalk dust
31	781	74	11	11	yes	yes	yes	supply off, window open, 23 computers, window mounted a/c, 10 CT
30	806	77	13	1	no	yes	yes	supply off, floor fan
29	733	77	9	8	yes	yes	yes	supply off, window open, 22 computers
40	809	75	12	1	no	yes	yes	supply off, window mounted a/c, door open

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Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 6

Indoor Air Test Results –Greenfield High School, Greenfield, MA – April 14, 2000

Location	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Music Room	848	73	14	7		yes	yes	supply off, window mounted a/c

Comfort Guidelines

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CT = water-damaged ceiling tiles

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%

TABLE 7

Indoor Air Test Results –Greenfield High School, Greenfield, MA – April 26, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
Outside (Background)	451	50	48					
92	1188	70	24	20	yes	no	no	heater
91	1371	73	24	14	yes	yes	yes	supply off,
Hallway (outside 91)								water leak, 1 CT
90	1499	72	23	21	yes	yes	yes	supply off
93-Woodshop	739	72	19	21	no	yes	yes	supply off-missing motor, wood collection system-clogged
89	981	72	23	0	yes	yes	yes	supply off, chalk dust
88	1201	70	23	0	yes	yes	yes	supply off
94	945	71	20	15	yes	yes	yes	flammables-on open shelf-need flameproof cabinet, clay dust, thermostat
87	863	69	24	0	yes	yes	yes	supply off, unvented kiln, door open

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CT = water-damaged ceiling tiles

Comfort Guidelines

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600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 8

Indoor Air Test Results –Greenfield High School, Greenfield, MA – April 26, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
95	784	71	20	3	yes	yes	yes	ozone generator
95A	1060	72	25	14	no	no	no	2 CT, dry erase board
96A	676	71	21	13	no	no	no	chalk dust, ceiling heater, 4 CT
96								oil on floor
97	726	72	19	12	yes	yes	yes	exhaust louver damaged, door open
86	808	76	16	4	no	no	no	air filter, chalk dust, door open, cleaning product
107	787	75	18	2	yes	yes	yes	exhaust off, chalk dust, door open occupants gone ~2 hours
106	1222	76	22	16	yes	yes	yes	supply and exhaust off, door open
107	771	77	16	0	yes	yes	yes	supply off, chalk dust
104	843	73	20	0	yes	yes	yes	exhaust off, door open, chalk dust
103	1113	74	21	16	yes	yes	yes	supply and exhaust off, door open, chalk dust

* ppm = parts per million parts of air
CT = water-damaged ceiling tiles

Comfort Guidelines

Carbon Dioxide - < 600 ppm = preferred
600 - 800 ppm = acceptable
> 800 ppm = indicative of ventilation problems
Temperature - 70 - 78 °F
Relative Humidity - 40 - 60%

TABLE 9

Indoor Air Test Results –Greenfield High School, Greenfield, MA – April 26, 2000

Remarks	Carbon Dioxide *ppm	Temp. °F	Relative Humidity %	Occupants in Room	Windows Openable	Ventilation		Remarks
						Intake	Exhaust	
110-Science	870	79	17	0	yes	yes	yes	
Cafeteria	1071	77	21	300+	yes	yes	yes	supply off, door open
Gym	813	74	20	0	no	yes	yes	
Back Gym	704	70	23	4	no	yes	yes	supply not functioning, door open

Comfort Guidelines

* ppm = parts per million parts of air
CT = water-damaged ceiling tiles

Carbon Dioxide - < 600 ppm = preferred
 600 - 800 ppm = acceptable
 > 800 ppm = indicative of ventilation problems
 Temperature - 70 - 78 °F
 Relative Humidity - 40 - 60%